FOREST CONDITIONS IN OHIO

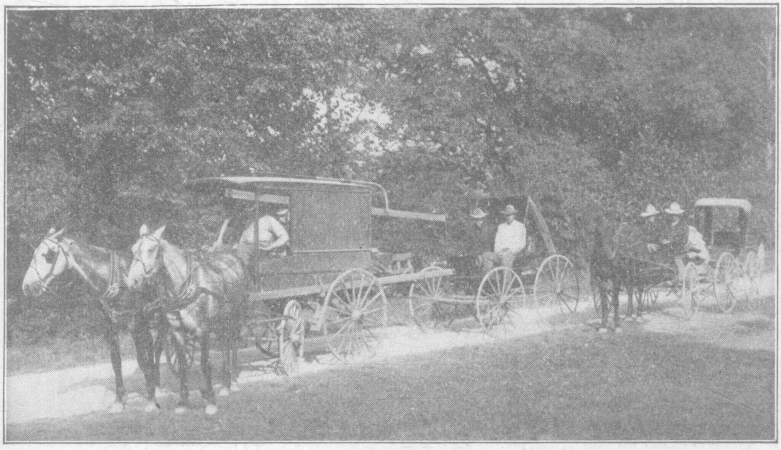
A RECONNAISSANCE SURVEY OF THE NATURAL FORESTS AND ARTIFICIAL FOREST PLANTATIONS IN THE WALHONDING VALLEY AND PARTS OF CENTRAL AND SOUTHERN OHIO.

OHIO

Agricultural Experiment Station.

WOOSTER, OHIO, U. S. A., JUNE, 1909.

BULLETIN 204.



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[1]In cooperation with the College of Agriculture, Ohio State University, Columbus.
[2]In cooperation with the U. S. Department of Agriculture.
[3]On leave of absence with the Miami Conservancy District.

BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 204 JUNE, 1909

FOREST CONDITIONS IN OHIO.

BY W. J. GREEN AND EDMUND SECREST.

A RECONNAISSANCE FOREST SURVEY.

INTRODUCTION.

The forest survey of a certain portion of Ohio during the current year has been in the nature of a reconnaissance. It was not intended to cover the ground thoroughly but to make a preliminary examination of the forest conditions, in preparation for more detailed work. Preliminary work was also necessitated by the fact that the cooperative forestry plots established by the Station from year to year since 1904 required inspection, in order that directions for the management might be given and notes on their condition might be secured.

The direction taken and the area covered were determined largely by the fact that the majority of cooperative forestry plots were in the specified area. The plan was to inspect such plots as were old enough to yield results in the rate of growth of the different species of trees. Systematic measurements along with other data were taken in these groves. Plantings made in 1907 and 1908 were inspected when convenient and suggestions for their management were given, but no special effort was made to see them, it being the intention to return to them when the trees are of suitable size for more appreciable results.

Another important feature of the work has been the examination of the native forests. A certain percentage of typical woodlots were examined and a report of existing conditions made. Suggestions as to methods of improvement were also given. In cases where owners were indifferent, only general reports were made but on the other hand detailed directions were given to those manifestly interested. Aside from this, parties who desire to engage in tree planting were also seen and their ground examined, planting plans were made and where conditions warranted, agreement was made to furnish seedling trees by the Station. More interest was manifested in clear plantings than in woodlot improvement, although in the latter a decided increase in interest the current year over last is apparent.

The survey of the Walhonding Valley has been considered a matter of prime importance. (1st) from a topographical aspect. The steep slopes and rugged hills are in many places unfit for agricultural purposes. (2nd) from a hydrographical aspect. The denuding of these hills will seriously affect the regularity and uniformity of stream flow, and be a detriment to the inhabitants along the valley as well as to the possible use of the stream as a power derivative in the future. (3rd) for reasons of the growth now existent. There are hundreds of acres of second growth stands, the species of which are the best for timber utilization and which will be sizable in a few years.

TERRITORY COVERED.

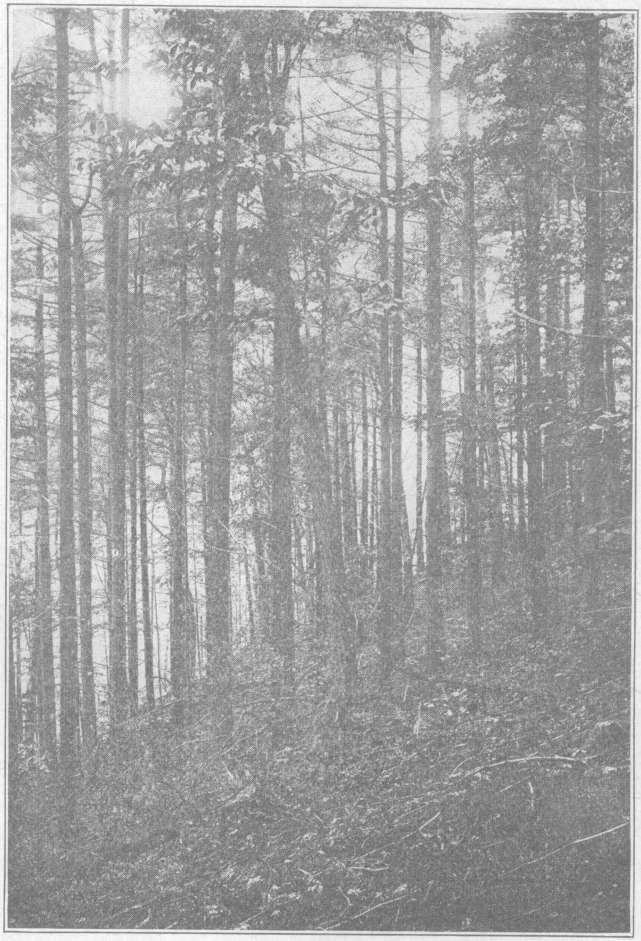
The territory wholly or partially covered includes the counties of Ashland, Knox, Holmes, Coshocton, Morrow, Delaware, Marion, Union, Franklin, Madison, Fayette, Clinton, Butler, Montgomery, Highland, Greene, Champaign, Clark and Clermont. The area covered within these counties was determined by the location of cooperative forestry plots, by typical woodlot areas and by any particular features of interest to forestry.

THE WALHONDING VALLEY.

The term Walhonding valley in this report includes the tributaries Lake Fork, Black Fork and Clear Fork. The term Mohican is applied to the river between the junction of the Clear and Black Forks, which is approximately two miles south of Loudonville, and the village of Walhonding. Preliminary work in the way of determining the percentage of forested and deforested land along the immediate river slope was commenced. Strip surveys were conducted over an area ten miles in length and approximately two miles in width.

WHITE PINE STUDIES.

This valley contains the largest area of white pine growth in the state. It occurs in mixture with hardwoods and hemlock and in occasional pure stands. The latter, however, have sprung up since the removal of the virgin hardwood stands, and in abandoned fields and pastures. It is most commonly found associated with scarlet, white and black oaks, chestnut, pignut hickory and hemlock. The culled condition of the original hardwood forest makes the conditions for germination and growth of the pine seedlings exceptionally favorable. That white pine is encroaching upon the hardwood growth along the immediate river slopes is obvious upon investigation. Such encroachment is more evident in under normal stands of hardwoods, thus by their shade tolerance forming the lower story of the forest.



Second growth White Pine.

In some cases the hardwoods are unfit for timber products, with the exception of fire wood, for which there is no market. This condition unfortunately is a serious hindrance to the removal of the trees which is sometimes necessary after the pines become of certain age.

Second growth White Pine encroaching on old field.

White pine prefers southerly and westerly exposures. It is also found growing on the thinnest and most sterile soil. This condition, however, is not likely a matter of preference. In view of reforestation it is a pleasing fact that white pine encroachment indicates its preponderance in this section and no better native tree can be found for the purpose. It not only yields lumber of high quality but is a fast growing species and one well adapted to check erosion. Its well marked degree of shade tolerance will make it an excellent tree for under and interplanting. Some idea of the rate of growth and growing value of pine may be obtained from the following table. The estimates of value are based on local stumpage prices.

ONE ACRE OF WHITE PINE, 40 YEARS OLD, KNOX COUNTY.

Number of trees	260
Number board feet at present time	3,585
Probable number board feet 10 years hence	6,228
Average annual increase, board feet	264
Average annual increase in value per acre	$5.28

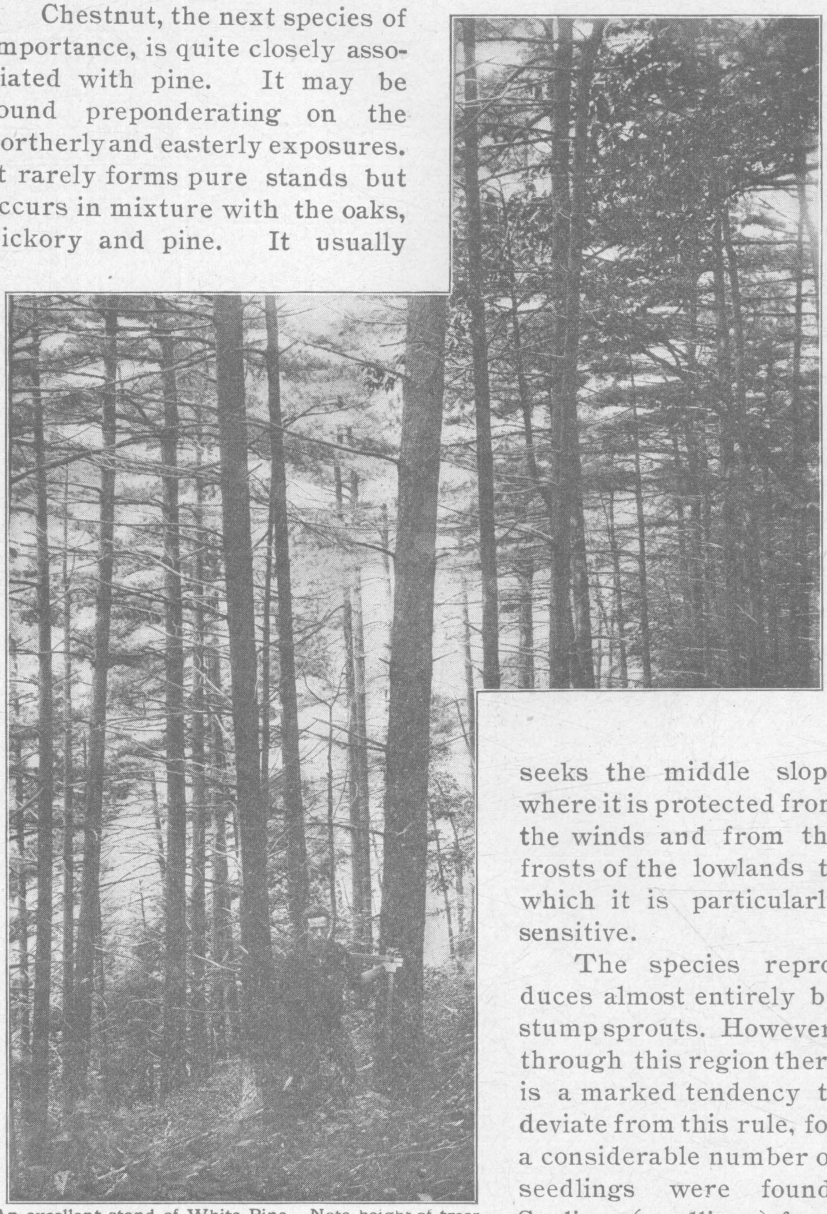
This plot represents a second growth stand of pine above the average. It, however, does not represent the full possibilities in white pine culture. Cognizance must be taken of the fact that the accretion of this stand for the next ten years will in all probability reach its maximum of decade growth and the accretion will be less thereafter. There is no rule governing this, however, and such rate of growth must be determined in each locality.

White Pine reproduction among hardwood nurse trees.

In almost every stand of this or similar character, important work needs to be done in the way of management. If they were reenforced by planting, improved by thinning, or in many cases had the nurse trees taken out, the returns would have been better and secured at an earlier date. In making these estimates on future growth and value, no consideration was taken of the probable rise in stumpage prices of white pine within the next ten years.

The hemlock is quite closely associated with pine, but is slower growing, more tolerant of shade and demands a greater degree of moisture than pine. The quality of its products is much inferior to pine, and it is hardly worth considering as a commercial species. As an undergrowth it is excellent. It shades the soil and is of much value in preventing erosion, on the steep northern river slopes, for which location it has a decided affinity.

Chestnut, the next species of importance, is quite closely associated with pine. It may be found preponderating on the northerly and easterly exposures. It rarely forms pure stands but occurs in mixture with the oaks, hickory and pine. It usually seeks the middle slope where it is protected from the winds and from the frosts of the lowlands to which it is particularly sensitive.



An excellent stand of White Pine. Note height of trees.

The species reproduces almost entirely by stump sprouts. However, through this region there is a marked tendency to deviate from this rule, for a considerable number of seedlings were found. Saplings (seedlings) from 4 to 12 feet in height are rare. The adaptability of the species to the geology of the region is apparent. It is doubtless a tree among the hardwoods which should be largely utilized for reforesting. Too much attention cannot be given to favor its regeneration, both by

protecting little seedlings and especially preserving and fostering stump sprouts from which the future chestnut forests will largely come. (This species will be treated of in detail in a special publication).

Hanover township, Ashland county, in which the first woodlot examinations were made, consists for the most part of high hills which are covered with glacial drift and the debris of the local rocks. Outcrops of the coal rocks occur as well as the Waverly conglomerates (sandstone) and the Cuyahoga shales. The soil is usually clay, tempered with sand and gravel, containing a great abundance of rock fragments, while granite boulders are very abundant, some of them several tons in weight. The rock fragments are serving a useful purpose in the fact that they preserve the steep slopes from washing and cause the rains to penetrate the soil and aid to a great extent, the work of under-drainage. The alluvium of the valleys renders them fertile and for the most part they are very productive. The flora of the valley is varied and interesting. Its mention is of importance because of its vast influence silviculturally. The occurrence of shrubs are the indicators by which silvicultural practices must be gauged.

Jefferson township, Knox county, is similar in topography to Hanover township. Its surface represents a succession of hills in part rugged and steep, especially when influenced by the coal measure rock, and the Waverly conglomerate. The hills are intersected by narrow ravines, in which flow the tributaries of the Walhonding and smaller streams, the latter uniformly occupying ancient valleys of erosion and bordered by rich alluvial plains.

The hills are all symetrically rounded at the top and are composed almost wholly of the Waverly sandstones. Some of the hills contain patches of undisturbed drift on protected slopes with scattered erratics, the latter sometimes very abundant on the lower slopes and in the beds of the streams.

On the ridges and steep slopes white pine, chestnut, scarlet, black, red and white oak preponderate. Hemlock is also found on the steep, rocky, northern exposure. Its range, however, is limited to the extreme northern part of the township. At the extreme northwestern portion of the township, on the eastern and northeastern exposures, there exists a remarkable variety of species. Upon these slopes and locations patches of the drift still remain. The presence of red oak, scarlet oak, chestnut, white maple and pignut hickory have no significance but here are found white walnut, black walnut, cucumber tree, red elm, white ash and sugar maple. All of these species are found distributed within the province of the Waverly sandstones. The good drainage afforded by the deep deposits of gravel fully explains the presence of sugar maples.

Thirteen woodlots, containing 680 acres of forest, were examined. Of these eight were used jointly as woodlot and pasture land, and five were unpastured. The majority of these forests are of mixed type, both as regards species and size of species. In practically every woodlot some consistent systems of management are needed. The first and fundamental requisite is that sheep be excluded from portions where timber is to be grown. It is absolute folly to allow sheep to range over the steep slopes where there is no grass, and where only the young seedlings of valuable species and protective undergrowth are growing. Such pasture does not average fifty cents in value per acre per annum, and the wholesale destruction to young forest and the loss in soil fertility through erosion is many times the above amount.

If pasture alone is desired, it would be far more practical to clear the entire area of trees, and seed the ground to grass. Erosion would be less liable to occur. Few "weed trees" occur in this area. Probably the scarlet oak should receive mention under that term. It is quite prevalent and its presence is always undesirable on account of its inferiority commercially and its spreading and general distorted habit of growth. Matured individuals of any species become "weed trees" when they interfere with the young growth. The regeneration, except in very few instances, is not what it should be. The majority of second growth stands are under normal. Here reenforcements by artificial means is the most practical method of securing a normal growth. In many places the growth is of such a character that improvement by way of inter- or underplanting is impracticable. Nor is it practicable to hold the timber as it is, A clear cutting should be practiced in such cases. Replanting can then be done in a more profitable manner.

Washington township, Holmes county, is for the most part similar to the above named townships. Innumerable creeks and small streams, interlocked in the most irregular manner, flow through the various alluvial valleys or deep rocky gorges, which separate the high hills that compose the greater part of the surface.

The constant succession of hills exhibit continuous exposures of all the rocks of the lower coal measures. The soil generally is a friable, calcareous clay loam. The surface of the hills is so thickly covered with rock fragments, the debris of the coal sandstones, as to be unfitted for cultivation. Their very nature should insure forest reserves for the future. Here chestnut, red, scarlet, black and white oak and pignut hickory preponderate. White pine and hemlock occur in the extreme north-western part of the township. Along the slopes of the Mohican, chestnut is quite abundant throughout the township and is the most important species commercially.

The tree species vary little. Chestnut, red, white, scarlet and black oaks, red maple, sugar maple, white pine, hemlock, dogwood, pignut hickory, mockernut hickory, white ash, serviceberry, large toothed poplar, beech, white and red elm, sassafras, black gum, sourwood, were the tree species found. As given in description of townships heretofore, the woodlots generally are in poor condition, although occasionally may be found excellent stands of second growth coppice chestnut. These usually exist where the land has no possibilities in the way of agriculture, and are not the result of effort, but mere indifference, and unfortunately they are, in some cases at least, considered as evidences of neglect. Here, too, sheep have been the potent factor in creating unnatural forest conditions. The woodlots bear evidence of damage by pasturing. Here the wood pasture is valued at a small figure while some of the pine and chestnut stands are producing a net profit of four or five dollars annually. Not so in the pastured forest, in almost every case where woodlot pasturing has been practiced for years, neither woodlot nor pasture is a paying investment and the capital involved is virtually inactive.

Richland township, Holmes county, is similar to the preceding townships both in geology and forest. The numerous second growth stands of sprout chestnut, white, red and black oaks embrace the commercial species. These are all more or less in mixture with the scarlet oaks. Some few virgin white oak stands exist toward the eastern portion of the township, but these tracts are being rapidly cut over by contract for railroad cross ties. Here is a good example of mis-utilization. These trees, many of them two and three feet in diameter capable of being converted into high grade products, are being sold by farmers in a way that not over two-thirds of their actual value may be expected.

The same may apply in the utilization of chestnut pole trees for cross ties and lumber. More waste is always attendant in the latter practice, besides the products do not have the proportional value.

Butler township, Knox county. In this township 12 woodlots comprising 125 acres were examined. This area, while still within the influence of the Walhonding Valley, is not in the valley proper. Evidences of the drift are present, but the soil is quite largely the result of local debris. The Waverly sandstones prevail. The coal measure rocks are present in some of the recently eroded ravines. There are occasional sandy ridges, but wherever the drift is in evidence the ridges and hills are usually capped with clay. The soil resulting from the local debris is less fertile than that of the drift deposits.

The forest growth varies. The chestnut slope or ridge does not exist in any case as would be supposed. Sugar maple grows where drift deposits exist but on soil well drained and usually underlaid with gravel. Upon these locations may be found also, beech, black gum, red maple, white ash, shellbark and pignut hickory, ironwood, blue beech, white and red elm, tulip poplar, black and white walnut,white, black, scarlet and red oaks, and black cherry. The sandy locations are more inclined to grow chestnut, black oak, pignut hickory, red maple, white and scarlet oaks. A number of excellent second growth white oak stands exist here. Along with these stands come the pastured woodlot. There are many stands of second growth ash, oak, etc., that may be improved by interplanting some species adapted to soil and other conditions. Here as elsewhere a large number of the woodlots are not real forests but mere woodland pastures, in which matured trees predominate and grass forms the forest floor. In order to proceed to establish forests the entire growth should be removed and the area reforested by artificial means. The white pine is a promising tree for a large portion of this township and can be planted with considerable assurance of success.

Perry township, Coshocton county, lies almost wholly in the great coal fields. Its surface in appearance is hilly yet there are no ridges, and rarely any point of considerable elevation about the general summit level. The soil is largely a derivation of the limestone formation and in consequence is fertile. Chestnut is rare. The forest growth is confined to sugar maple, beech, black walnut, butternut, white ash, white, red, black, and scarlet oaks, ironwood, blue beech, sassafras, black cherry, ash, tulip poplar (yellow poplar), dogwood, large tooth poplar and black gum.

The western portion of the township, in which the Waverly shales preponderate, contain scattered specimens of chestnut but pure stands are lacking. There is less tendency to pasture woodlots as severely in this township than in some of the ones previously mentioned, and in consequence there are some fair second growth forests. Having received no attention, however, the regeneration has taken the course of the least resistance and much of the growth is of those species which seed freely and which tolerate considerable shade. Unfortunately such trees happen to be those of an undesirable class, and usually unfit for lumber. Beech, ironwood, blue beech and black gum are included in this class. Having once taken possession of the ground they form stands of such density that it is almost impossible for the natural regeneration of more light demanding and valuable species to take place.

If white ash seed trees are present the area is quite likely to be reseeded to that species. Its comparatively rapid growth will insure its predominance when once established. The same is often true of yellow poplar. It is usually more profitable to proceed to restock such a woodlot artificially than to wait for the natural growth. Sometimes, however, where a natural growth is established it cannot be improved upon artificially, nor can it be accomplished as economically. It must be remembered, however, that in the great majority of cases artificial regeneration is by far the better method of reforestation, because it enables the planter to choose those species he desires and to begin operations with a normal stand. Here as elsewhere the reproduction groups itself, due probably to more favorable conditions for germination and growth, but ironwood and blue beech unfortunately form a large percentage of the second growth stand.

Tiverton township, Coshocton county. In this township are splendid stands of white ash reproduction. These stands are the result of natural seeding. Below is a table showing the actual number of white ash seedlings and associates on one-tenth acre:

White ash	1,340	Black oak	7
Sugar maple	40	Red oak	6
Hickory	27	Black walnut	4
Black cherry	25	Ironwood	2
Red elm	12	Total number trees	1,463

In this proportion there would be at the rate of 14,630 seedlings per acre, probably nearly ten times the number necessary to plant by artificial means. Yet such stands as the above are of value for two reasons, first, it was seeded without cost, and second, the density of the stand is bound to produce clear lumber. Year by year the stronger individuals of the stand crowd out the weaker ones but at the same time the height growth is forced by the crowding and the side branches are killed by shade and fall off through the influence of wind and other causes. Artificial thinning in such cases is never practical until the trees removed in the thinning are large enough to be used for some purpose.

Monroe township, Knox county, in topography and forest is somewhat different from those of the river type. The hills are symetrically rounded and of very graceful outlines, especially where composed of the olive shales of the Waverly sandstones. They are usually covered with drift containing abundant debris of the Waverly and many granite boulders. Patches of typical clay drift are most abundant on the slopes near the tops of the hills.

Beech, sugar maple, white, red, black and scarlet oaks, white and black ash, black walnut, ironwood, dogwood, pignut hickory, cherry, silver maple, shellbark hickory, chestnut, black gum, tulip poplar and sassafras abound. The wooded pastures are more numerous here than in previously named townships. The trees, in a majority of the woodlots are matured and nothing is to be accomplished by letting them stand. Chances for natural reproduction of valuable species to take place are small. The encroachment of sod has practically destroyed all forest conditions. In some of the woodlots improvement cuttings can be made, that is, the large matured trees or those of weed species can be removed from among the valuable individuals.

The large beeches are a source of much damage in many woodlots. Growing as they do with the spreading habit they usually allow no reproduction to take place within reach of their branches. This species should be eliminated from the woodlots as soon as possible. It is undesirable, both as regards quality of lumber and rate of growth. Beech lumber is usually inferior to the other species and it is among the slowest growing. Its lack of durability in or out of the ground is marked and commonly observed. Its elimination from the woodlots of this township should be among the first of forestry operations.

Here also the value of the woods pasture is much less than what might be expected from a normal stand of timber, or from a pasture free from the influence of trees and shrubs. The catalpa, white pine, red oak, tulip poplar and in some cases locust would be the species to use in restocking the woodlots.

Considerable similarity in conditions exists between the previously described township and Pleasant, Harrison and Morris.

College township, Knox county. The forest land of this township consists quite largely of virgin growth, having been controlled by a corporate institution. There is an abundance of black and scarlet oak, but in most places the stands are too thin. In some cases it would be best to sacrifice these groves, and replant, or to locate the woodlot on poorer soils, or those portions that have been exhausted by constant cropping.

Liberty township, Knox county. The woodlots in this township are of the mature, wooded pasture types. Many of them must be entirely cut off and a new start made if profitable woodlots are desired.

Examples typical of the entire western and southern portion of Knox county may be found in the seeding of undesirable species in the woodlots through natural means. Below is given a table showing the result in an unpastured woodlot where certain undesirable seed trees exist as a result of natural reseeding.

NUMBER AND SPECIES OF TREES GROWING UPON A PLOT 25 FEET SQUARE:

Ironwood	80	Cherry	6
Black gum	4	Serviceberry	15
Dogwood	2	Hickory	7
White maple	37	White oak	4
Black oak	9	Scarlet oak	1

Total number trees per acre..... 11,484

According to the ratio of species, as given in the table, the undesirable species, ironwood, black gum, serviceberry and white maple, form practically 80 percent of the stand, Possible exception might be made of white maple as being an undesirable species, but for the location from which the plot was taken its space could well be devoted to other species. It can thus be seen that utter dependence upon nature alone in the regeneration of woodlots is liable to bring about an aggregation of species unfit for any purpose of utilization, excepting firewood, for which there is no demand in this county. This condition of growth also augments the necessity of cutting out the possible seed trees of these "weed" species in order that the woodlots may be aided by natural regeneration.

There was growing in close proximity to the foregoing plot, one of entirely dissimilar character. In this case the commercial species preponderate. The area of this plot is 30 feet square.

NUMBER AND SIZE OF TREES ON PLOT 30 FEET SQUARE.

	Number	Average height, feet.	Average diameter, inches.
White ash	19	25.8	1.5
Black cherry	23	24.1	1.8
Sugar maple	22	14.7	1.1
Shellbark hickory	1	10.0	1.0
Dogwood	3	.....	.....

Total number of trees per acre..... 3,400

It is readily apparent that the density of this stand has a marked influence upon the height growth. The crowded trees are not only straight and tall but free from branches. The crowns are high, conical and compact, making the ideal forest tree. A dense growth yields timber free from knots and it is the quality of lumber which controls the price. Therefore it is far better at the start to allow the trees to grow closely together, and when the clear length has reached one or two logs lengths a thinning may be made, thereby allowing diameter growth to take place, by the development of branches from above the clear log lengths.

This plot was located upon a gentle northeastern slope, the soil being a clay loam of no exceptional fertility. It will be noticed that a variation in the growth of the different species exists.

The age of the various species is approximately the same. The ash is apparently the most rapid grower, as it has attained the highest diameter and height growth. Of three preponderating species the sugar maple has made the least growth. This tree is much slower in growth and, but for the fact of its large degree of shade endurance, would have succumbed early in the struggle. Neither cherry nor ash would have tolerated the shading to which the maple has been subjected. The western townships of Knox county contain a number of sugar maple groves, all of which are in need of careful management to preserve them.

MORROW COUNTY

The soil of this county presents great diversity. The flat portions have a heavy clay. The sandstone district lying east has a lighter, more porous soil. Stones and gravel are almost never seen in the western part of the county, but in the eastern the plow turns them up frequently. The timber varies noticably with the change in soil. A large percentage of the native forest trees are beech, the remainder consisting principally of sugar maple, ash and the oaks. The chestnut is confined to the gravelly and rolling portions in the eastern part of the county.

This county probably contains, on the whole. the best type of second growth woodlots seen in the territory covered by the survey. Both pastured and unpastured types exist, but the individual second growth stands are far in excess of those in any other county. Ash and maple are the species chiefly composing these stands, although in several places normal groves, containing tulip poplar, cherry and white oak, are found. A feature of special importance here is the regeneration of sugar maple in the shade of large trees in unpastured woodlots. In places the growth is remarkable and is an excellent example of natural reforestation in sugar groves, where there is no interference by live stock.

NUMBER AND DIFFERENT SPECIES GROWING ON A PLOT 30 FEET SQUARE

Beech	382	White ash	12
Sugar maple	174	Tulip poplar	2
Cherry	14	Total number trees	584

Total number of trees per acre..... 29,200

The seedlings completely covered the ground, as can be assumed by the number on the plot, and were growing under a leaf canopy of large trees, which almost completely shaded the ground. While their development was exceedingly slow they are the nucleus of the future forest, moreover, they are creating the most favorable forest conditions for the other trees by preserving an excellent leaf mulch and in turn shading the ground. It is impossible for sod to encroach

on the forest floor under such conditions. While these seedlings are old, slow growing and apparently worthless, as soon as the larger trees are removed and the sunlight can get to the leaves of the small trees they will immediately spring up.

The above plot also indicates what should be the attitude of the woodlot owner toward the beech. Here this species forms 65 per cent of the stand. The land on which these trees were growing is worth $50 per acre. In order that the farm woodlot under such conditions may be profitable the species grown must either be of a fast growth or possess durability or value to the owner. Beech has neither of these virtues. It is slow growing and lacks value, in comparison with other native forest trees. The same may be said of the black gum. It is true the older specimens of these species sometimes possess value; for instance, good specimens of "red beech," and "yellow gum", so called on account of age and slow growth, may be manufactured into the finest quality of durable lumber. But it must not be expected that 150 or 200 years will have elapsed in order to produce the lumber of the future. We must look to trees of more rapid growth with which to reforest our woodlots, and be content to utilize them at a size that now might be considered too small for use. While it cannot be doubted that the older and slower growing trees produce the best grades of lumber, yet it is to be expected that in our system of forest management we must provide for periods of rotation in harvesting the forest crop, and that these periods of rotation must necessarily be short on account of the present scarcity of the supply. In fact the shortest cut to the securing of the forest product must be taken, and the land upon which the forest stands must produce all it is capable of producing. Such conditions can never come about until the undesirable "weed trees" and those matured are taken out.

Franklin township contains a number of woodlots in fair condition. Several have an excellent under story of ash and sugar maple seedlings. The large maple and beech should be removed in many cases, so as to give the young growth as much sunlight as possible. Here, as in every township of the county, there are a considerable number of producing sugar orchards. This business forms one of the profitable enterprises of the county. Some of the maple groves produce a net annual revenue as high as ten dollars per acre. But here are two institutions which do not work in harmony, viz., pasture and sugar grove. To be sure it is not known whether orchards will produce more sap,and that of better quality, where live stock is allowed access and natural forest conditions are destroyed, or vice versa, but it is known and cognizant to many that the trees in the pastured sugar orchard will die or become decrepit pre-

maturely. The majority of these groves are utilized for pasture purposes, the owners undoubtedly being in most cases entirely unconscious of the evil resulting therefrom. Trees of this character must have protection from the drying effects of sun and winds, and to this end the sod must be kept out. To do this it is necessary that an undergrowth become established. This will hold the leaves and shade the ground, thereby eliminating grass and hence the most undesirable of conditions.

In the majority of cases such undergrowth may be brought about by the mere exclusion of live stock alone. Many times seedlings spring up rapidly. In some cases certain species may be planted in the woodlot which will establish these conditions, and yet produce farm products in the way of posts and poles. Catalpa could be used for such purpose in many instances and occasionally locust. The latter, however, would better be used sparingly and should be planted in such a manner as not to interfere with gathering the sap. Evergreens would also be adapted for such purposes, although they are usually unfit for post or pole timber. The arborvitae would be an exception to this, as its timber is durable in contact with the ground. The white pine is well adapted to the underplanting of many sugar groves, but it is a lumber tree and must be used for such purpose. The ash is also well adapted to such operations and naturally reseeds itself in many cases where seed trees exist. Tulip poplar (yellow poplar) may also be used in some locations. It will not bear as much shading as some of the above named species, but it is a tree of moderate growth and excellent quality for lumber. Where it is desired to perpetuate the sugar grove the sugar maple is, of course, the best tree to plant. One excellent example of this method of improvement of the sugar orchard was found where the owner is making sugar from trees of his own planting. The planted trees have greatly improved the forest conditions.

In Lincoln township are a number of excellent stands of second growth ash. One instance in particular, a 40 acre woodlot in which is growing an almost perfect second growth ash stand, was practically bereft of its growth by a hurricane some fifty years ago. Enough seed trees of white ash were left remaining to reseed the area and the existing growth was the result. The following sample plot taken from the forest indicates the stand and suggests its present value and an approximate rate of interest on the investment in the way of an annual increase in growth. While the plot does not represent an entirely pure stand of ash, that species and sugar maple predominate. The figures given are for one acre.

FOREST GROWTH ON ONE ACRE

Species	No. of trees	Number Bd. ft. at present time	Probable No. of Bd. ft. 10 years hence	Average annual increase Bd. ft.	Average annual increase in value for one species
White ash.....	210	2930	4620	165	$3.30
Sugar maple...	115	1705	2645	94	.94
Black cherry.....	10	300	520	22	.44
Total for all species...	335	4935	7785	281	$4.68

This stand is an excellent example of natural seeding and unaided development, as a result of all natural interference being removed. This growth would never have resulted had not the storm carried away the large trees, hence removing the shade and thereby making possible the development of the present stand.

DELAWARE COUNTY

The geology of this county is varied. The eastern portion is underlaid by the Waverly group of sandstones. The land is rolling, which is probably due to the unequal deposits of the drift. The western part is underlaid with limestone. The deeply eroded valleys of the Scioto and Olentangy rivers constitute the most marked topographical features of the county. Toward the southern part of the county these valleys are deeply cut in the underlying rock. The soil seems to be generally dependent upon the nature of the glacial drift. It is so mixed with the various essentials that the strength and fertility are very great. Considerable gravel and stone exist in mixture in places, particularly in the rolling portion. The stones come partly from the underlying rock but mainly from the drift. The northwestern portion of the county has on the whole a heavy, clayey soil, and is comparatively free from boulders. Gravel is scarce but the streams show a great many northern boulders. The alluvial river margins possess a characteristic soil strongly contrasting with the generally clayey lands of the county. They are lighter and warmer and contain considerably more sand and loam. The whole county was originally wooded with deciduous trees.

Practically all of the remaining forests of this county are of the wooded pasture type. There still remain in the eastern and northern part of the county some few unpastured woodlots, but the most of these are in an unprofitable condition. Beech is one of the prevailing forest trees, and through its inferior quality many have been left standing as culls, when the lumber trees were removed and sold. No efforts were made to create conditions for reproduction, but instead the sheep and cattle were allowed access to the woodlot. Such species as would regenerate under the

conditions, viz: beech, ironwood and blue beech may be found in places, and quite frequently in the unpastured forest the worthless species will spring up first and take possession of the soil. Ironwood, beech and black gum are particularly prone to this habit.

The comparatively high price of land in this county has been a discouraging feature for forestry operations, and it can never be expected that this phase of agriculture will be given any prominence. Granting the above it may be said, however, that land set aside for operations in the way of forming windbreaks for animals and buildings, and products for direct farm use, will not lack returns proportional to the investment. There are a large number of so called woodlots through this section, which are being held at a dead loss to the owner in every respect; the growth existent consists of distorted and worthless beech, gum, maple and ironwood fit only for firewood, and with a poor market for such utilization is absolutely worthless from the aspect of growth increment and is paying no interest on the investment. It is the general admission of woodlot owners that the average woods pasture yields small profit. In some cases, where beech predominates, there is a very meager sod, and many times not one-fourth of the ground produces grass. Here then, from two aspects, is a loss to land owners of this county, and while we have no adequate knowledge of the amount in figures, it is evident that the annual loss in holding the majority of these wooded pastures in their present condition is considerable.

Afforestation here must be carried on not by the reclaiming or improving these pasture woodlands, but by entirely removing them and starting anew by artificial means. It is often the case that the soil of these woodlands is of most excellent quality, due of course to being on virgin ground. It was often the case that the woodlot was the portion considered the poorest piece of ground and left in trees and pasture for that reason. Long continued cropping of the better portions, however, has made this erstwhile barren soil more productive than the better portions. It is advisable then in many cases to give the woodlot ground over to tillage and select some exhausted and thin piece of ground for growing trees. In this county everything along forestry lines must be obtained by commencing at the bottom and the sooner the start the quicker the results. Nothing is to be gained by waiting, and nothing need be expected from natural reproduction.

In Radnor township are some good second growth white ash and sugar maple groves, and in this township also will be found the greater number of unpastured woodlots.

The following plot was taken in Delaware township and will show the possibilities of this species under favorable conditions. The Table indicates the growth on a plot 25 feet square.

NUMBER OF TREES ON PLOT 25 FEET SQUARE.

Ash	216
Sugar Maple	7
White Elm	10
Red Oak	2
Trees per Acre	16450

This plot was taken from a woodlot in which the young growth was grouped and did not represent the average woodlot. On an adjacent plot of the same area were growing 3 white elm and 10 beech. This then again indicates nature's methods of reaf-forestation. Man's assistance is necessary in order to bring the entire woodlot into productiveness.

There are several species of trees which can be used to advantage in woodlot management in this county. The catalpa is well adapted to the limestone area west of the Olentangy. There are several thrifty groves in the eastern portion also. Some damage has been done by the ravages of the catalpa midge. In only one grove however was serious injury obvious. The planting of the locust is almost useless in the county, generally, on account of the ravages of the locust borer, an insect which perforates the wood of the tree, injuring its quality and in many instances killing the trees outright. Several groves have survived the injuries received and are practically matured, but the quality of the wood has been reduced considerably by the honeycombed borings.

Norway spruce and white pine and Austrian pine will be found well adapted to the soil of the eastern portion, particularly where it is influenced by the Waverly group of sandstones. These three species are especially well suited to satisfy the needs of a windbreak, the establishment of which is to this section of considerable importance.

FRANKLIN COUNTY

Franklin county contains a smaller percentage of forest lands than any of the counties heretofore mentioned. The comparatively high price of land and its value for trucking and dairying makes it almost impracticable to retain forest lands of any magnitude. There are many wooded pastures in the county which are being held at a loss. Practically all of the standing timber trees are culls or species of inferior timber qualities. The forest capital is virtually inactive and becomes less productive each year. The operations here must consist in the planting of the more rapid growing

species for general farm use. The problem of windbreaks will become more and more apparent. The topography of the county makes the windbreak a valuable adjunct to all farms. The catalpa, Norway spruce, white and Austrian pine are well adapted to such needs. Many groves of catalpa and mulberry are being planted throughout the county, the ultimate purpose being to have them serve as windbreaks to orchards, buildings and fields.

The same conditions prevail with greater or less variation in Madison, Fayette and Clinton counties. In this region the combination of woodlot and windbreaks is desirable. The former still has a few second growth woodlots which have value, but the pastured woodlot with a few standing matured and cull trees forms the rule.

An especially fine woodlot of 50 acres, consisting of second growth hickory, ash, white, black, scarlet, burr and pin oaks, sugar maple, hackberry, honey locust, white, red and water elm, red mulberry and pignut hickory was found in Clinton county. The stand was mixed, consisting of a number of large, matured specimens which were distributed among the young trees. The shellbark hickory apparently regenerated in a heavy sod, for the latter still exists. For the most part, however, the ground cover is excellent. Practically the only operation by which the forest could be benefitted would be the removal of the large, matured oaks and hickories. These individuals are retarding the growth of the young trees about them and besides they have attained their developement and should be marketed. The water elms might be removed also, especially where they interfere with the growth of the more valuable species.

ARTIFICIAL FOREST PLANTATIONS

THE ASH

During the survey of Fayette county an interesting plantation of ash was found near Washington C. H. The trees had been planted about 17 years previously and were spaced about 4 feet each way. The growth is fairly even, and but few of the trees have died as a result of crowding, but the entire growth is below normal, and had the trees been spaced 8 by 8 or 10 by 10 feet thinning would probably not have been necessary before the trees became of size so that the timber could be used for some purpose. Thinning has been necessary for some time, but the product can be used so far as is known only for firewood, for which there is practically no market. There has been an advantage in the close planting which should not be overlooked, viz: clear timber. It is impossible for lateral branches to develop and height growth is

always augmented. It would no doubt have been better had the ash been spaced wider and some such species as catalpa planted in mixture with it. When crowding commences the catalpa could be removed and utilized for posts and the ash left standing to attain larger size.

Natural seeding of White Ash after a clear cutting.

THE MULBERRY

Through the last named counties there are several small Russian mulberry groves. On the whole the results from 2 to 5 years' growth are poor. Its susceptibility to winter killing makes its growth in many sections distorted and stunted. Its inclination is to grow scraggly which makes it important that the trees should be pruned from the beginning. They develop many lateral branches which are very persistent, and after the trees become larger it is more difficult to remove the branches and secure clear timber. The species is well adapted for the formation of wind-breaks, and its prolific fruiting propensities make it desirable about orchards, where it serves as a means of attracting birds who are exceedingly fond of the fruit.

This tree thrives best upon a well drained, calcareous soil. It does poorly on heavy clays and wet and sour soils. Light loam, underlaid with a limestone gravel, suits the species best and on such locations it has been found to develop quite rapidly, and in fact as rapidly as the catalpa under similar conditions.

THE CATALPA

The consideration of catalpa groves is of greater importance than those of any other artificial plantatations, both on account of their majority and of the adaptability of this species to a large portion of the state.

Out of 645,270 trees distributed by the Experiment Station since 1904, 426,812 were catalpa. Its rapid growth on good soils has made it popular in the good farming sections of the state, for post and pole material, and for windbreaks. It is comparatively free from the attacks of insect and fungus diseases. Thus far the former have been more prevalent than the latter. The catalpa midge has probably been the most damaging, upon which a report will be found in bulletin 197 of the Experiment Station.

During the past summer measurements were taken of a number of groves throughout the area covered by the survey, to obtain data on the rate of growth.

GROWTH OF THE CATALPA

On the whole the growth of the groves has been as good as could be expected. There is considerable variation, due to both quality and chemical composition of soil. From the aggregate of results, marked difference in growth is shown between soil of freestone and limestone formation, that on the latter being better than on the former. Again considerable variation in growth exists as a result of individual management (cultivation, pruning, etc.) Below is given a tabular statement of the growth of a grove in Clinton county.

SIZE OF 4-YEAR-OLD CATALPAS IN CLINTON COUNTY.

Diameter one foot from ground	2.3 inches
Diameter breast high	1.9 inches
Diameter 7 1-2 feet from ground	1.4 inches
Average height	13.0 feet

These trees were growing upon a white clay soil of only moderate fertility, which had been considerably worn by constant cropping. They had received two years of cultivation, having been set at a distance of 8 feet each way. Very little pruning was done, and the trees were in some cases inclined to become "stag headed" or bushy in appearance. Judicious pruning in this case would improve the quality of material by securing a straight bole and

better height growth. Diameter growth in this case was excellent because of the copious development of lateral branches. The effect of good cultivation is obvious. A five-year-old grove indicates the effect of non cultivation. The soil was of moderate fertility and is of freestone formation, being a reddish clay loam.

SIZE OF 5-YEAR-OLD CATALPAS IN CLINTON COUNTY. NOT CULTIVATED.

Diameter one foot above ground	1.0 inches
Diameter 4 1-2 feet above ground	0.3 inches
Average height	8.0 feet

The above probably represents an extreme type of the uncared for grove, but it must be emphasized here that the majority of failures are from lack of attention in the matter of cultivation.

The following tabulation represents an average of five 5-year-old groves in Morrow county. They were planted on clay loam of considerable fertility.

AVERAGE OF 5-YEAR-OLD GROVES IN MORROW COUNTY.

Diameter one foot above ground	3.4 inches
Diameter 4 1-2 feet above ground	2.0 inches
Diameter 7 1-2 feet above ground	1.0 inches
Average height	12.0 feet

In two of the groves included above, small posts can be cut at the present time. These groves had received cultivation for the first year at least and some for two years. All but one had received pruning to a greater or less degree.

PRUNING THE CATALPA

This operation is fundamental in the production of a catalpa grove, and is one in which the greatest diversity of opinion exists among laymen as to methods of procedure. Methods must necessarily vary, according to the products and purposes for which the trees are intended. It has been found in most cases that trees have been pruned either too copiously or not at all. Lateral branches are necessary in order to obtain diameter growth, and the more leaf surface the tree has the faster it forms the diameter, which is just as essential as height growth. It is the ultimate aim in most cases to obtain a straight tree free from limbs, which is the ideal condition. This cannot be accomplished by too severe pruning at the start. The removal of all side branches will cause an increased height growth at the expense of diameter, thus the stems of the tree are not large enough or sufficiently lignified to support a heavy crown, which is a characteristic of the catalpa. The result is a crooked and distorted tree and through the action of heavy wind and rain storms the tops of the trees are liable to be broken off entirely. It is therefore better to remove the lower branches each

year, allowing a goodly number to assist in forming the diameter or body of the tree. Some prefer to pinch off the buds where branches form during the dormant season and have a whorl of branches where the following season's growth commences.

A Catalpa Grove in which the trees are suffering from the effects of severe pruning.

The point to be emphasized however, is that an equilibrium between height and diameter growth be maintained. Among the first cooperative groves the Station instructed the cooperators to cut the trees off at the ground when two years of age. The resulting sprout would attain practically the same height of the parent stem the following season, besides being straight and free of limbs. While in theory this plan was good in the majority of cases it was not practical. As could be expected the growth was extremely rapid and the sprout could not lignify properly as it grew, and was unable to support the heavy leaves, thus placing

the entire grove at the mercy of the wind and rain storms. Many of the trees were distorted and are worthless. Some were broken off where stump and sprout join and in others the tops were gone. Such conditions as described above invariably existed where the trees were planted in good soil and exposed to the wind. There exists no need for cutting back an entire plantation of trees regardless of straight or crooked trees. It will often be found necessary to cut off individual trees in plantation, because of inferior or distorted growth, but the ones standing will afford protection thereby eliminating danger of sprout destruction. A somewhat crooked tree when small will always straighten itself as it grows larger, so if the crook is not too marked it would be better to let nature remove it than to create an unevenness in the grove by cutting the tree back. Many plantations injured through being cut back will have to be recut in order to obtain a satisfactory and even growth. During the past two seasons the Station has advised cutting off the trees about an inch and a half above the point where the stem and root join at time of planting. This insures a straight growth at the beginning and permits of few sprouts from the stump which would otherwise come from a year or two year old stump.

DIFFERENT METHODS OF PRUNING A 4-YEAR-OLD CATALPA GROVE.

TREES NOT PRUNED—NO SIDE BRANCHES REMOVED

Diameter 1 foot above ground	2.7 inches
Diameter 4 1-2 feet above ground	1.3 inches
Diameter 7 1-2 feet above ground	0.6 inches
Average height	9.2 feet

TREES PRUNED EACH YEAR—ALL SIDE BRANCHES REMOVED

Diameter one foot above ground	1.9 inches
Diameter 4 1-2 feet above ground	1.2 inches
Diameter 7 1-2 feet above ground	0.6 inches
Average height	9.2 feet

TREES CUT OFF WHEN TWO YEARS OF AGE-ONE SPROUT ALLOWED TO GROW

Diameter one foot above ground	1.4 inches
Diameter 4 1-2 feet above ground	0,7 inches
Average height	6.0 feet

It can readily be seen by referring to the table that the unpruned trees have attained a greater diameter growth and possess a more tapering stem, than those which had all of the side branches removed. It will also be seen that the height of all the trees of the two plots is the same. While the unpruned trees have made by

far the better diameter growth it must not be inferred that they produce the best and most desirable trees. When trees are wholly unpruned some are liable to become distorted in growth and many are unfit for utilization. It must be seen however, that branches are a necessity to a growing tree but they must be removed as it becomes necessary in order to produce a well formed tree. The data taken on the sprouts of the trees cut back show inferior growth in comparison with the other two treatments. The advantage in this method is to secure a straighter tree. Where the trees are reasonably straight the best method known at present is to remove a portion of the side branches each year, the operator using his judgement in shaping the tree. Take a middle ground between the method of removing all branches and none at all.

THE SPECIES OF CATALPA

There are quite commonly distributed over the state three distinct species of the catalpa, viz: the hardy catalpa, *catalpa speciosa*, common catalpa, *catalpa catalpa* (*bignonioides*) and the Japanese catalpa, *catalpa kaempferi*. Only the former or hardy catalpa is worthy of growing for commercial purposes. Its growth is more erect and more rapid, and its wood is more durable and of better quality than the other two species. Aside from the three species named there is a hybrid of the hardy catalpa and common catalpa which is quite commonly distributed.

It is unfortunately the case, that many catalpa trees and much seed which is sold for the hardy catalpa are spurious. Many plantations consisting of such species exist in Ohio. In fact the large majority of the matured groves consist of either the common catalpa or a hybrid of it. It is still more unfortunate that year by year this species is still being planted, either through lack of knowledge or misrepresentation. One should make careful investigations before buying trees or seed. A good way is to gather one's own seed if seed trees are available and many good specimens of seed trees exist in different parts of the state. Seed should never be gathered from a tree in close proximity to another of the spurious or common kind, no matter how good a type of hardy catalpa the seed tree may be, unless there is absolute knowledge that it was entirely out of bloom before the bignonioides trees commenced to flower. In such cases there would be no risk of hybridization. Too much importance cannot be attached to the fact that the greatest difficulty in the establishment of catalpa plantations lies in securing the species true to name.

FINANCIAL POSSIBILITIES

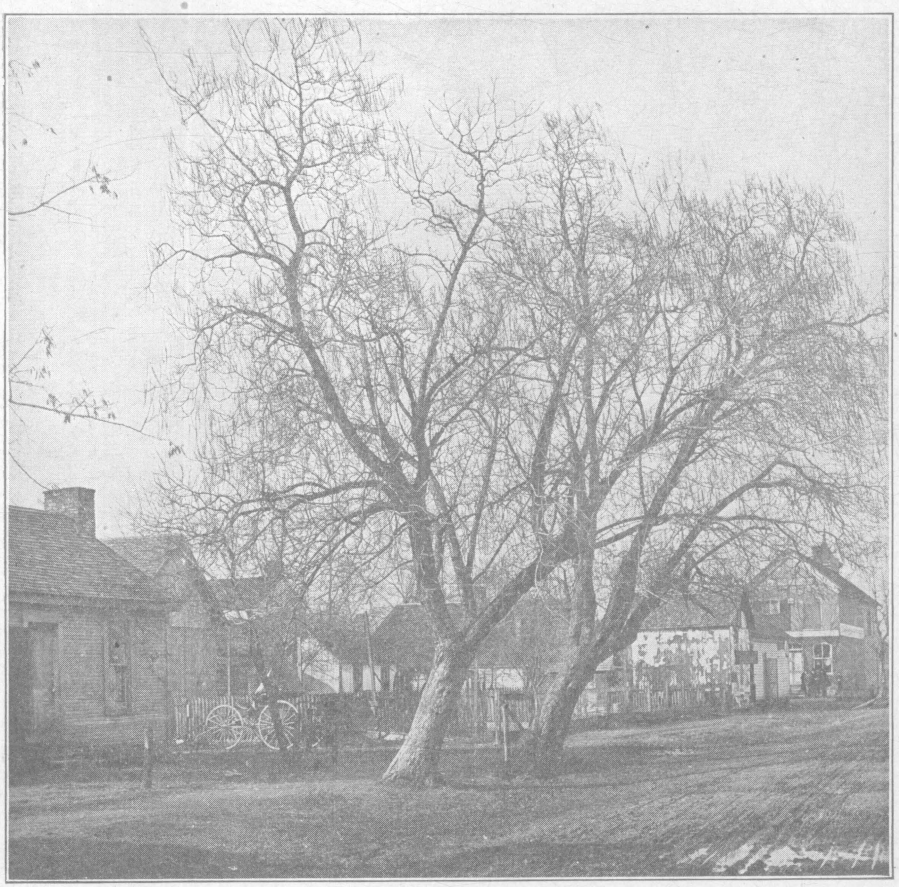
Estimates on the rate of growth were made on twenty-seven plantations above fifteen years of age.

The following table illustrates the relative value of a grove containing the two species, growing under similar conditions.

COMPARATIVE VALUE OF TWO SPECIES OF CATALPA

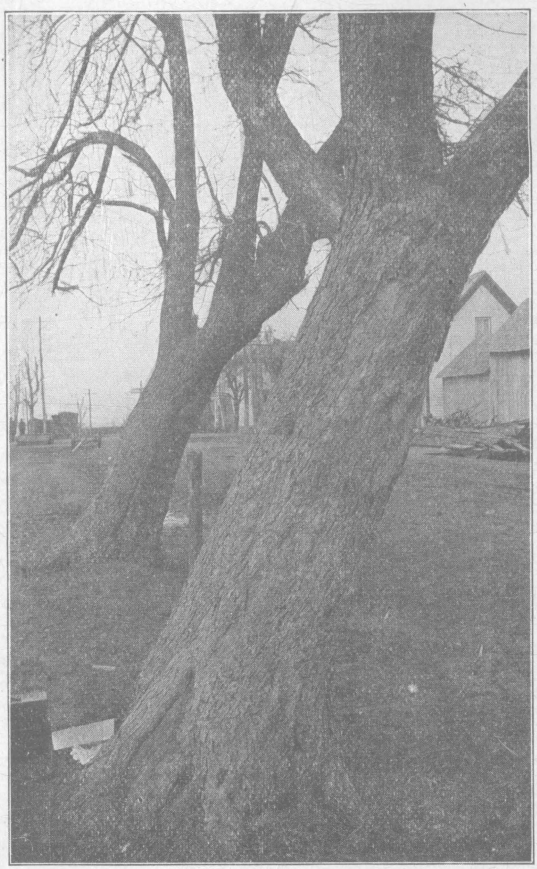
	C. speciosa	C. bignonioides
Average diameter 4 1-2 feet from ground, inches.....	11.5	10.3
Estimated average number of posts per tree.	9.0	5.9
Number of first class posts per acre.....	1797.0	880.0
Number second class posts per acre.....	197.0	352.0
Value of posts per acre.....	$191.52	$109.12

The wood of Catalpa bignonioides possesses some degree of durability but it is relatively inferior in this respect to that of the speciosa. This is easily demonstrated in the tendency of the lateral branches to decay and fall off sooner in the former than in the latter.



Common catalpa (Catalpa bignonioides) characteristic habit of growth.

The grove from which the above data were taken was planted in the spring of 1881. The trees were purchased in two lots, one lot proving to be the speciosa and the other the bignonioides. The soil conditions under which they were grown are so similar, and the spacing, cultivation and management so identical that the above data represent as fair a test of the growth of the two species as could be obtained. The spacing of this grove was 14 by 14 feet.



Trunk of the common catalpa (bignonioides) characteristic markings and habit of growth.

Careful measurements of all the trees were taken and an estimate of the number of posts in each grove was made. These plantations include both the speciosa and bignonioides as well as their hybrids, and are quite representative of different conditions of soil, site, moisture and distance of planting, all of which are factors influencing the growth of the catalpa. In some cases it was

impossible to ascertain the past history of the groves, and hence but little is known of their management. No doubt many were misused and mismanaged and it is difficult to obtain accurate data of what could be expected of a catalpa speciosa grove. As previously stated no definite conclusions can be drawn from the matured groves regarding the proper distance of planting. True they give suggestions, but no definite results. Considerable attention was given to this phase in the various cooperative groves established by the Experiment Station, but more time is required to make conclusive statements.

Sufficient data have been secured to indicate a variation in growth as a result of different distances of planting, even in 5-year-old plantations. Close planting, however, will not yield timber free from branches as in the case of many forest trees, and all attempts to secure clear boles will result in loss of growth. Dead branches adhere to the catalpa with decided persistence, and in many groves 25 years old and over, form a dense network. Artificial pruning in such a case is absolutely necessary to secure timber free from knots. Good soil combined with considerable degree of moisture will bear closer planting than that which is more sterile and devoid of moisture.

GROWTH AND VALUE OF A PLANTATION IN CHESTER TOWNSHIP, CLINTON COUNTY

Number of trees per acre	1,037
Age	24
Distance of planting, feet	6 x 7
Average diameter 4½ feet from ground, inches	7.1
Average number of posts per tree	2.3
Number of first class posts per acre	2,656
Number of second class posts per acre	236
Value of posts per acre	$279.76
Average annual increase in value per acre	$11.65

The soil upon which these trees are growing is a clay loam of medium fertility. It has good natural drainage with limestone near the surface. The trees were never cultivated and have received very little pruning, That they are the true speciosa can be readily determined from the excellent character of their growth. They possess good height growth and are exceptionally free from lateral branches. Estimates indicate upward of 110 poles per acre.

The following data are taken from the average of twelve plantations grown in Clinton, Fayette, Madison and Union counties. The trees range in age from 18 to 28 years. They were planted at varying distances. In one the trees were as close as 1½ x 6 feet, in another they were 3½ x 4½ feet. The widest distance of planting

was in a 28-year-old plantation in which the trees were set 14 x 14 feet. As far as could be ascertained the groves had received no cultivation and but little pruning. The soil in most cases was of moderate fertility and in some cases it was extremely fertile.

AVERAGE VALUE OF TWELVE PLANTATIONS OF CATALPA

Number of posts per acre	2,710
Percent first class posts	70
Percent second class posts	30
Value per acre	$198.59
Average annual increase in value per acre	$8.54

The maximum production was that of a grove in Union county in which were estimated 4,780 posts per acre, valued at $412.80, or an average annual increase in value of $18.76. The minimum production was that of a grove producing 1134 posts per acre, valued at $97.24, having an average annual increase in value of $4.86. The former grove was on excellent soil and the trees were planted at a distance of 4 x 8 feet. While practically receiving no pruning they possess good height growth and clear boles. The trees of the latter grove were planted upon a cold, white clay, devoid of humus and inclined to be wet and sour. There were some large trees in close proximity to the grove, in fact so close as to somewhat injuriously affect the catalpa. The trees stood 6 x 6 feet. It is not to be doubted that with our present knowledge, meager as it is, the returns from these groves can be materially increased. Many would probably have doubled in value had they been properly cared for in the way of cultivation, pruning, thinning and spacing.

THINNING

To grow the greatest number of trees per acre, without interference, should be the aim in establishing tree plantations. Although spacing the trees 4 x 4 feet is generally conceded to be too close, yet under certain conditions such distance or perhaps a little more space might be used, providing the products of thinning could be utilized when the trees commence to crowd each other. Ordinarily, where trees can be utilized no sooner than when post size, this distance would be too close, excepting possibly for locations where the soil is extremely fertile. The trees in some of the older plantations were planted as close as 3½ feet each way. In such cases the different individuals began to interfere with the growth of each other very soon. Examination of trees showed marked suppression in growth at the period when it should ordinarily have been at its maximum.

A few of these plantations have been thinned, but more time must elapse before results can be obtained. Indications are that the trees in a grove planted 3½ feet each way, which are now 16 years old, will recover from the suppression after having every other row removed. Marked accretion in growth was noted after the removal of every other row in a grove of catalpa hybrids 18 years old and planted 7 x 7 feet each way.

THE LOCUST

Locust trees are numerous and well distributed over the portion covered by the survey. Thousands of volunteer sprouts come up annually along roadsides, in pasture fields and waste places generally. The value of the species for post timber is known by all, and its production for that purpose would be particularly profitable but for the liability to attack by borers. Few trees and groves have escaped the ravages of this insect. Some have been injured very little while others were totally destroyed. The workings of the insect are not yet fully understood nor is the apparent immunity of some individuals from its attack.

It has been observed that the attacks of the insect on trees growing among other trees is considerably mitigated. The species will doubtless serve a useful purpose in reforesting woodlots having thin stands. It may also be useful in rejuvenating sterile and eroded fields and in stimulating the growth of grass in worn out pasture fields, even though its products are worth little. It was found to reach its best development in the southeastern portions of Clinton county, in close proximity to the limestone outcrops. The quality of the trees is excellent as is their growth in height. There are no evidences of borer attacks.

One grove in Union township, Clinton county, was totally destroyed—every tree being dead at 16 years after transplanting, while a grove 25 years old and not over three miles away was practically free from attack.

Locust trees should receive but little pruning. If properly spaced the side branches die in the course of time and drop off, leaving the trunks clear. These branches are necessary to aid growth while the tree is young, and then removal will result in the formation of more to take their places. It has been observed that insects are inclined to work more freely in the pruned than in the unpruned trees. It is of utmost importance, however, that forked trunks be prevented. They should be detected and one of the forks removed as early in life as possible.

THE OSAGE ORANGE

Several groves of this species, varying in age from one to fifteen years, were examined during the summer. The older ones indicate a fair growth, although not as rapid as the catalpa or the locust. The oldest and largest grove seen was found in Union township, Clinton county. Osage and locust were mixed in equal proportion. The latter outgrew the Osage from the start, somewhat suppressing them, but were finally totally killed by the borers. The original spacing was about 3 x 6 feet, the rows being six feet apart and the alternated trees three feet apart in the row. The death of the locust gave the Osage 6 x 6 feet spacing. Practically all of the trees have survived and in fertile soil posts could be cut. This species does not prune itself naturally, and close planting will not produce the desired effect, but will result in loss of growth. In view of this fact it would be better to plant the rows wider apart and the trees closer in the row. This will facilitate pruning by giving plenty of space in the rows for getting about and piling brush.

A plantation of Osage Orange.

The durability of the Osage wood in contact with the ground is well recognized, and is unsurpassed by any other post timber growing in the state. The species has an advantage in that it may be utilized when of smaller size than other post timbers. The full pos-

sibilities of the tree have not been shown by any grove examined thus far. The trees in the Clinton county grove above mentioned were suppressed by the more rapidly growing locusts. The other groves studied were mostly too young.

GROWTH OF AN OSAGE ORANGE GROVE IN CLINTON COUNTY

Age	8 years.
Diameter 1 foot above ground	2.1 inches.
Diameter 4½ feet above ground	1.6 inches.
Diameter 7½ feet above ground	1.3 inches.
Height	13.0 feet.
Distance of planting	3½x4 feet.

This plantation was growing on a fertile black loam, along a ravine. The trees are apparently crowding at this time, although considerable pruning has been done.

THE BLACK WALNUT

Several planted groves of this species were examined during the survey of Holmes and Morrow counties. The oldest was found in Prairie township, Holmes county. Nuts were planted eight feet apart each way where the trees were to stand permanently. The stand is not normal; probably some of the nuts never germinated, others may have been eaten by rodents. The planting was made in 1876. The grove contains 403 trees which will have an average diameter, four and one-half feet from the ground of 6.5 inches. The height was approximately 50 feet. The trees did not possess a thrifty appearance and some are dead. In fact it appeared as if the maximum of growth was attained and that deterioration had begun. There was no apparent reason why deterioration should begin at such an early period, as the soil upon which they are growing is a fertile loam of considerable depth, a condition which is naturally adapted to their best development. Indications are that the species does not thrive in pure stands, but requires for thrift and longevity the association of other species. Pure stands rarely if ever occur to any extent in nature. The trees are usually found associated with the oaks, elms, hickories, etc. Trees of this species growing in the open possess considerable sapwood, which decreases the value of the wood. Those growing in the forest or in denser stands have a greater percent of heart wood, hence are more valuable. It would doubtless be an excellent plan to grow catalpa or some post timber in mixture with this species, the former, for instance, as the walnut is dependent upon the same conditions for best development. The walnut, however, should be allowed to grow for several years before the catalpa is planted, so as to give it a good start and avoid possible suppression by the catalpa, which is the faster grower. A final

spacing of about 6 x 6 feet would allow the catalpa to become of post size before thinning would become necessary, thus leaving the walnut to reach lumber size. The walnut is slow in starting its growth and is difficult to transplant on account of its well developed tap root. The seedlings may be transplanted when one year old but it is usually more satisfactory to plant the nuts in permanent location and to place them closer together than trees would be planted, so as to allow for a germination of about 50 percent under ordinary conditions. In some cases squirrels, chipmunks, etc., destroy the entire seeding. Sprouting the nuts before permanent planting will sometimes prevent this.

JACKSON COUNTY

Jackson county lies wholly in the great coal measures of southeastern Ohio. In topography it is rough and hilly and the surface of the county has never been modified by the deposits of the drift. It presents the peculiar features that a country exposed to the wear and waste of atmospheric agencies for thousands of years must show. The soil is made up of the local debris. The Waverly sandstone underlies practically the whole county. The sterile sandstone soil is everywhere rich in iron, and the ore was much sought during the middle of the last century. An abundance of coal underlies practically the entire county.

The principal forest trees consist of the following species:

Black Oak *Quercus velutina*
Chestnut Oak *Quercus Prinus*
White Oak *Quercus alba*
Scarlet Oak *Quercus coccinea*
Yellow Oak *Quercus acuminata*
Spanish Oak *Quercus digitata*
Red Oak *Quercus rubra*
Pin Oak *Quercus palustris*
Post Oak *Quercus minor*
Lea's Oak *Quercus Leana*
Cow Oak *Quercus Michauxii*
Swamp White Oak *Quercus platanoides*
Burr Oak *Quercus macrocarpa*
Shingle Oak *Quercus imbricaria*
Yellow or Tulip Poplar *Liriodendron tulipifera*
Chestnut *Castanea dentata*
Beech *Fagus Americana*
White Elm *Ulmus Americana*
Red Elm *Ulmus fulva*
Hackberry *Celtis occidentalis*
Red Mulberry *Morus rubra*
Red Birch *Betula nigra*
Cucumber tree *Magnolia acuminata*
White Ash *Fraxinus Americana*
Black Ash *Fraxinus nigra*
Black Cherry *Prunus serotina*
Sycamore *Platanus occidentalis*
Black Gum *Nyssa sylvatica*
Large Tupelo Gum *Nyssa biflora*
Sweet Gum *Liquidambar styraciflua*
Black Walnut *Juglans nigra*
White Walnut (Butternut) *Juglans cinerea*
Bitternut Swamp Hickory *Hicoria minima*
Shellbark Hickory (shagbark) *Hicoria ovata*
Big Shellbark Hickory *Hicoria laciniosa*
Mockernut Hickory *Hicoria alba*
Pignut Hickory *Hicoria glabra*
Yellow Locust *Robinia Pseudacacia*
Honey Locust *Gleditsia triacanthos*
Persimmon *Diospyros Virginiana*
Sassafras *Sassafras sassafras*
Sourwood (Sorrel tree) *Oxydendrum arboreum*
Sugar Maple *Acer saccharum*
Silver or White Maple *Acer saccharinum*
Red or Scarlet Maple *Acer rubrum*
Buckeye *Aesculus glabra*
Large-Toothed Poplar *Populus grandidentata*
Cottonwood *Populus deltoidea*
Serviceberry *Amelanchier Canadensis*
Dogwood *Cornus florida*
Black Willow *Salix nigra*
Sand Bar Willow *Salix fluviatilis*
Red Bud *Cercis Canadensis*
Pawpaw *Asimina triloba*
Ironwood *Ostrya Virginiana*
Box Elder *Acer Negundo*
Blue or Water Beech *Carpinus Caroliniana*
Crab Apple *Malus coronaria*
Pitch Pine *Pinus rigida*
Shortleaf Pine *Pinus echinata*
Jersey Pine *Pinns Virginiana*

These species occur with greater or less frequency throughout the county under varying conditions of soil, moisture, etc. For the most part the timber lands of the county are included in what are known as the "Furnace Lands." These tracts, embracing from 200 to 12,000 acres in extent, contained a considerable quantity of iron ore and were controlled by companies and individuals who operated furnaces for the purpose of reduction. These furnaces, operated about the middle and latter part of the last century, were heated by charcoal instead of coke, and it was necessary that considerable timber be at hand in order to supply the coal. In consequence all the virgin timber has been removed and in some instances even the second and third growth was utilized. The growth, subsequent to the removal of the virgin forests, is largely coppice or sprout growth, although some seed stands exist upon the different tracts. With the exception of chestnut these coppice stands are inferior, and the trees rarely attain any size without being infested with rot fungi.

FOREST TYPES

Primarily there are four prevailing forest types to be found, although the two first named are sometimes interchangeable.

1. **Ridge type,** containing inferior growth of black oak and chestnut oak, with an occasional admixture of yellow locust. The latter two species are frequently of good quality. The stands of chestnut oak are sometimes exceedingly dense and the locusts are usually quite free from the attacks of the borer, which is not the case with isolated individuals and groves.

2. **White oak slope type** contains white, black and red oaks, hickory and chestnut in varying mixtures, the white and black oak usually preponderating. The height growth and general conditions of the forest are good. The slope affords better protection from wind, besides a soil having more fertility and moisture.

3. **Cove type,** consisting of tulip poplar, chestnut, red elm, black walnut and occasionally ash and sycamore (the latter is rare). These localities produce the straightest and tallest trees, and those freer from limbs, and consequently the best grade of timber.

4. **Creek or swamp type** consists usually of pin and burr oak, white elm, willow and elder.

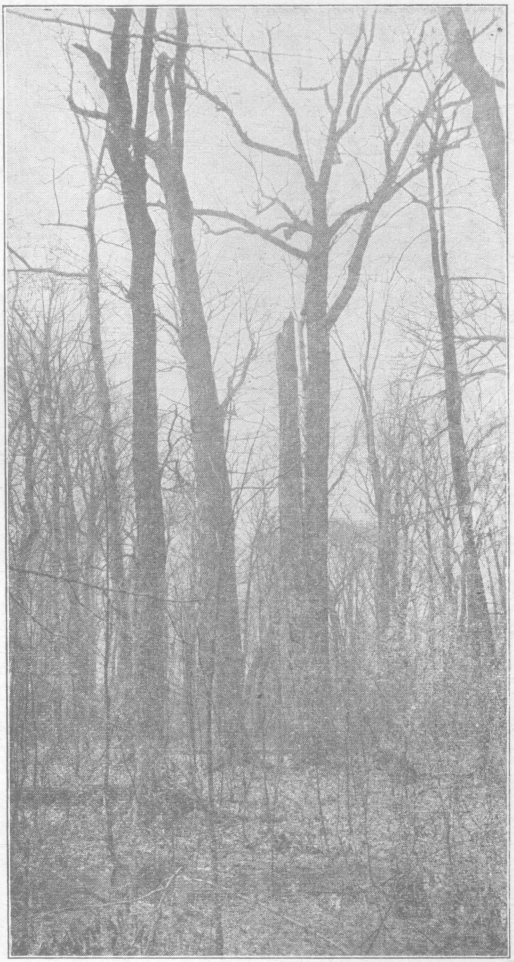
FOREST ENEMIES

By far the greatest destruction to Jackson county forests has been brought about by the frequent fires, which have swept many of the tracts time and again. The result is not only a destruction to the ground cover which is the important factor in establishing forest conditions, but to the trees themselves. In many instances where

the trees are not killed outright the lower portions of the trunks are so severely scarred that healing over is impossible, which makes an excellent entering place for fungus diseases, and the lumber is usually unfit for any purpose by the time the tree is matured. Besides the absolute destruction of young seedlings, the best condition for the germination of seed is removed, by the destruction of the leaf litter, leaving the ground and rocks entirely bare of humus. Those tracts in close proximity to steam railways suffer most and it may be said that the steam engine is the potent factor in setting fires. A large portion of the Richland furnace tract, situated in Washington township, Jackson township and Richland township, Vinton county, has been repeatedly burned by such cause. There is absolutely no remedy excepting strict surveillance exercised by patrol. Fire lines would assist in the work, but would not in themselves be effective. A lesser percentage of the fires occurring are started by hunters, smokers and trespassers. Fire control cannot be mitigated by the mere enactment of laws. The statutes cover the matter thoroughly and specifically, and the damage in many cases results from an absolute disregard of law.

SECOND GROWTH

The greater part of the forest upon the furnace tracts is second growth. A considerable portion of the Richland and Superior land contains third growth. In both cases unfortunately the trees are largely stump sprouts, which can never develop to large size without great danger of decay. Such trees may attain railroad cross tie size in fair condition, but the securing of larger sizes is doubtful. The smaller the stump the better the stump sprout. i. e., sprouts from the stump of a young tree are always healthier and less liable to succumb to decay than those of older trees, besides having a greater and more vigorous sprouting capacity. For certain market conditions sprout forests are desirable, because they reproduce to a certain size in less time than a seed forest could, but unfortunately such markets do not exist. There is of course no demand for fire wood. Mine props and railroad ties are practically the only purpose for which the small timber can be utilized and it is not especially well fitted for such purpose, consisting largely of black and scarlet oaks, neither of which make first class mine props or railroad cross ties. In some few localities the growth is used in the manufacture of charcoal, although this business thus far has not assumed any proportions. Considerable inferior timber may be utilized for such purpose and that of wood distillation in the future.



Unpastured virgin forest.

The tendency of white and chestnut oaks to reproduce by seed is marked. Numerous stands of this species are found upon the tracts previously mentioned. The chestnut oak in particular occurs with considerable frequency. It is a prolific seeder. A large percentage of the acorns are fertile and they germinate under adverse conditions. The species is well suited to sterile soil and establishes itself with great persistence upon the tops of the apparently most barren ridges. The white oak stands are not as dense nor does the species possess the seeding qualities or high percentage of seed germination that the chestnut oak does. The latter will germinate and take root in the most sterile soil entirely

devoid of humus and leaf mold. This makes it especially valuable for reforesting areas repeatedly swept by fire. The growth is more rapid than that of the white oak, and it nearly equals that of red and black oak. For railroad ties and posts it practically equals white oak. Indications are that it is more durable in contact with the ground than white oak.

A woodland pasture.

WEED TREES

The furnace forests contain many of these trees. They consist of the distorted specimens and coppice sprouts of the black and scarlet oaks. The latter species in particular has a tendency to produce a distorted growth. The trees are usually limby, punk

knotted and generally unhealthy. The timber is inferior and always contains considerable sap, which lowers the quality. Black oak, toward the tops of ridges and in mixture with chestnut oak, is usually inferior. The black gum, although not common must be thrown in this class. Its prolific seeding tendency makes it undesirable. It possesses but little value as a timber tree and is very slow in growth. The large-toothed poplar is of mushroom growth during its early life, and is very apt to appropriate vacant spaces where timber has been removed. It is short lived, rarely attains a diameter over 16 inches and does not tolerate the shading of other trees. It thins itself readily in dense stands, and when it takes possession of space it hinders the development of other species. It is practically of no value excepting for pulp wood. The beech in some cases acts as a weed tree, but its presence is limited. Its spreading habit of growth serves to suppress more valuable timber trees that grow about it. It is desirable to eliminate these species from the forest whenever possible and to replace them with trees of value.

VALUE AND RATE OF GROWTH OF ONE ACRE OF SECOND GROWTH FOREST

	White Oak	Chestnut Oak	Red Oak	Black Oak	Locust	Total
Number of trees per acre.....	237	183	29	88	4	541
Board feet per acre.....	3,100	1,995	405	915	16 posts	6,415
Probable board ft. 10 yr. hence...	4,860	3,585	780	1,545	25 "	10,760
Average increase in board ft. per A	176	159	37	63	9 "	435
Annual increase in value per A	$1.76	$1.54	$0.38	$0.50	$0.45	$4.68

In a great many places the stands may be improved by the removal of some species and the planting of others, and in some places by a simple process of thinning. In some cases it would be far better to remove the entire growth and start anew by planting. This would apply to places where scarlet and inferior black oak form the stand.

OLD FIELD TYPE

There are distributed throughout the furnace tracts, as well as elsewhere, a considerable number of fields cleared for tillage purposes at one time or other during the past. The timber growth was taken off and the land farmed until the fertility was exhausted, when it was abandoned and allowed to revert to forest. These fields were usually located on slope or ridge where erosion was apt to take place. The sedge grass was the first vegetation to appear, after

which the sassafras, persimmon and sumac began to encroach. In some places the two former species have taken complete possession and have started the work of reclamation. These worthless species are the forerunner for the forest. They establish forest conditions and create a favorable environment for the larger and valuable forest trees, which gradually come in and finally replace the sassafras because of its smaller size and inability to withstand the shading. To wait for satisfactory forest growth to establish itself would be folly from a practical aspect. One might wait a hundred years and yet the area would reproduce no trees of commercial value. In reafforesting an old field it is far better to proceed by artificial means, than to wait for nature to accomplish the purpose in a round about way. The sooner the work is taken up after the field is abandoned the easier it is to accomplish results. In the southern part of the county there is considerable pine. Pitch pine, shortleaf or yellow pine and Jersey or scrub pine are the species found. There is a marked tendency for the species to establish itself on old fields, especially where seed trees are in close proximity to such locations. There are a number of excellent stands of pitch and shortleaf pine in this region which have come up on abandoned fields, and in one location the trees are being harvested at thirty-five years of age. These stands are of all ages and sizes, and the species establishes itself and thrives in locations where hardwoods cannot be successfully started. Nature's method of reafforesting old fields, as exemplified here, is one from which the forester should learn well his lesson. No species of tree growth is more effective in checking erosion and quieting the soil than the pine, and no species is better adapted to thin and sterile land or gives more promise of producing results than the pine. Old fields, which have regenerated spontaneously to the species, cannot be too carefully protected. The growth of the trees is excellent and the quality of timber good. The Jersey or scrub pine is inferior to the other two species on account of its branching habit and knotty timber. The shortleaf pine is freer from branches, makes better height growth and produces a better quality of timber than the pitch pine. The two are quite similar regarding rate of growth. Both the pitch and Jersey pine are prolific seeders and have a tendency to regenerate when the shortleaf will not.

On the Jefferson furnace lands, in Jefferson township, there are a considerable number of eroded areas. Some were doubtless old fields long since abandoned, others comprised those places where excavations for iron ore were made. The latter present a deplor-

able condition and are practically without hope of practical reclamation aside from planting. Locusts might do in places but white pine would probably be better.

VALUE AND RATE OF GROWTH OF ONE ACRE OF PITCH AND SHORTLEAF PINE

	Shortleaf pine	Pitch pine	Total
Number of trees per acre	229	236	465
Board feet per acre	3,225	3,420	6,645
Probable board feet ten years hence	5,225	5,405	10,630
Average increase in bd. ft. per acre	200	198	398
Annual increase in value per acre	$2.00	$1.99	$3.99